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The Mineral Industry of India



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The Mineral Industry of India

By Gordon L. Kinney¹

The value of mineral production in 1987 was estimated at \$8.2 billion,² a 10% improvement over that of 1986. The contribution from crude petroleum was the highest at \$4.1 billion. Others, in order of importance, were coal, \$3.1 billion; iron ore, \$235 million; limestone, \$170 million; and lignite, \$125 million.

India, the second most populous country in the world, was a major producer of a number of minerals and a major consumer of even more. Barite, cement, chromite, coal, iron ore, limestone, manganese, mica, mineral sands, and nitrogen fertilizer were produced in significant amounts. A considerable amount of aluminum, copper, lead, steel, and zinc was produced but sizable imports of these metals were also needed to meet demand.

Minerals were produced in nearly every State but a few areas contributed heavily. Production from Bombay High offshore oilfields had the highest value, accounting for 34% of the mineral total. It was followed by Bihar, 15%; Madhya Pradesh, 10%; Assam, 9%; Gujarat, 9%; West Bengal, 6%; and Andhra Pradesh 5%.

Some of the major developments during the year included the coming on-line of the National Aluminium Co. Ltd.'s (NALCO) main components. Alumina from the NALCO plant was exported to North Korea and Norway. The first potline of the Angul smelter was being debugged yet produced over 20,000 tons of aluminum ingot.

The Hazira-Bijaipur-Jagdishpur (H-B-J) gas pipeline was connected to the nitrogen fertilizer plant at Bijaipur, Madhya Pradesh, at midyear and then connected to a sister plant in Aonla, Uttar Pradesh, by the end of fiscal year (FY) 1987.³ The pipeline was one of several projects under way

to modernize the movement of gas, crude oil, and refinery products in India. A considerable amount of crude and refined oil products were transported long distances in India by rail and truck.

During 1987, a number of important investigations were conducted by the Geological Survey of India (GSI) such as geological mapping, mineral exploration, and mapping the seabed within the exclusive economic zone (EEZ). Some major achievements were geological mapping of 30,000 square kilometers at a scale of 1:63,360 and drilling 38,000 meters of exploration holes.

In the Burdwan District of West Bengal, core drilling intersected coal seams up to 9.5 meters thick at depths to 480 meters. The most encouraging discoveries were seams 3.1, 2.2, and 1.2 meters thick at depths of 72, 94, and 107 meters, respectively, in the Andal-Palashbari sector. In the Dumka District of Bihar, coal seams up to 15.9 meters thick were intersected to drilling depths of 294 meters. Drilling in the Sundargarh District, Orissa, revealed 15.0-, 19.3-, and 42.2-meter-thick coal seams at depths to 382 meters. Encouraging results were revealed in Khammam District, Andhra Pradesh, where a 16.4-meter seam was struck at a depth of 29 meters.

Exploration for lignite continued in the States of Tamil Nadu and Gujarat. Seams up to 2.4 meters thick were discovered but at depths that apparently were noneconomic.

GSI's most recent exploration work was at Bahoar near Pondicherry, Tamil Nadu, where 30 boreholes delineated a lignite deposit of 330 million tons, and in the West Garo Hills District of Meghalaya, where a 5-meter seam of good quality coal was found at a depth of 30 meters.⁴

The Mineral Exploration Corp. (MEC) is the Government unit that conducts detailed explorations and determines ore reserves after GSI has made the discovery. During 1987, MEC established about 490 million tons of new coking coal reserves, 1 billion tons of noncoking coal, and 380,000 tons of gold ore reserves.

Discoveries in recent years of potentially economic deposits of coal, graphite, limestone, marble, and oil have been made in the northeast in Arunachal Pradesh. Oil India Ltd. (OIL) has started modest crude oil production and Coal India Ltd. (CIL) has been authorized to develop a high-quality coking coal deposit in Tirap District. To exploit the mineral sector as expeditiously as possible, the State Government has set up a mineral organization, Arunachal Pradesh Mineral Development Corp., similar to mineral companies in several other Indian States. The State contributed 0.17% to India's mineral production value, virtually all from the modest flow of crude oil.

In August 1987, India's application for registration as a pioneer investor and its allocation of a mine site in the central Indian Ocean were accepted by the United Nations Preparatory Committee for International Seabed Authority. The United Nations accorded India, along with three other countries, pioneer status in deep seabed exploration. India was the only developing country to be so recognized and became the first to be allocated a 150,000-square-kilometer area for further exploration and development. The pioneer status entitles the country to its site but does not permit commercial exploration until the convention on the law of the sea is effective. India has had an active research program under way since before 1983 and qualified for pioneer status by spending at least \$30 million on the program. Extractive processing research on polymetallic nodules was under way at the Regional Research Laboratory in Bhubaneswar, National Metallurgical Laboratory in Jamshedpur, Hindustan Zinc Ltd. in Udaipur and Visakhapatnam, and Hindustan Copper Ltd. (HCL) in

Khetri.

India's mineral industry is planning a national drilling center. The United Nations Department of Technical Cooperation for Development will assist in establishing a \$5 million center at Nagpur. The center, to be run by MEC, will provide training and drilling technology. It will train technicians from mineral exploration companies, public sector organizations, and mining companies.

In a similar vein, the Oil and Natural Gas Commission plans to create an Institute of Petroleum Safety and Environment Management in Goa at a cost of \$7 million. The purpose of the Institute, the first of its kind in Asia, is to raise standards of safety, health, and environmental quality in the petroleum sector.

Electric power shortages have seriously hampered India for the past two decades. Despite the extremely rapid growth of capacity since 1980, the demand for power has grown faster than plants could be built. Power shortages have been exacerbated by 3 years of low rainfall. This has cut hydropower generation while increasing water demand for irrigation. As the farming sector has priority over industry, power for the mineral sector is frequently reduced or cut off. This has reduced metal production considerably. Aluminum, copper, lead, steel, and zinc, primarily, have been affected.

By yearend, power generation capacity in India was 57,000 megawatts consisting of 36,300 megawatts thermal, 19,430 megawatts hydroelectric, and 1,270 megawatts nuclear. The intended installation of 38,000 megawatts of additional capacity during 1990-95 is unlikely to be achieved because of delays in obtaining environmental clearances and inadequate funding. Government experts estimate that new capacity by 1995 is more likely to be 30,000 megawatts. In addition to increasing the power generation capacity, the transmission-distribution network was also to be renovated and extended on a priority basis. The plan required an additional outlay of \$50 billion to the year 2000.

PRODUCTION

The most important increases in mineral production during 1987 were coal, copper ore, kyanite, limestone, and zinc concentrate. The most significant declines in mineral production were barite, 37%; crude oil, 3%; and crude mica.

The value of mineral output in the principal producing States, except for Goa and

Karnataka, increased in 1987. The most impressive increases were 14% in Assam, 24% in Gujarat, 25% in Maharashtra, 12% in Orissa, and 17% in Uttar Pradesh. The value of mineral output value in Goa and Karnataka declined 20% and 2%, respectively.

Table 1.—India: Production of mineral commodities¹

(Metric tons unless otherwise specified)

Commodity ²	1983	1984	1985	1986	1987 ³
METALS					
Aluminum:					
Bauxite, gross weight thousand tons	¹ 1,976	² 2,093	² 2,281	2,338	2,685
Alumina, gross weight do	⁴ 450	⁷ 587	⁷ 587	⁶ 600	⁶ 700
Metal, primary	203,559	268,520	260,010	257,096	253,372
Cadmium metal	131	148	194	160	214
Chromium: Chromite, gross weight	359,932	423,000	560,000	629,671	623,591
Copper:					
Mine output, Cu content	37,774	44,132	45,892	48,103	54,835
Metal, primary:					
Smelter	³ 35,469	40,536	32,460	39,074	32,923
Refinery:					
Electrolytic (cathode)	28,368	32,580	28,020	37,853	⁶ 33,200
Fire refined ⁵	1,000	1,000	1,000	1,000	780
Total ⁶	29,368	33,580	29,020	38,853	33,980
Gold metal, smelter troy ounces	70,158	65,234	58,771	60,250	59,929
Iron and steel:					
Iron ore and concentrate:					
Gross weight thousand tons	38,800	41,026	42,545	47,800	49,411
Iron content do	24,289	25,682	26,633	29,923	30,931
Metal:					
Pig iron do	9,086	9,382	9,835	10,509	10,893
Ferroalloys:					
Ferrochromium (including charge chrome)	35,790	³ 55,578	66,497	84,000	93,945
Ferromanganese	150,880	³ 121,829	163,438	179,132	173,259
Ferrosilicochromium	1,675	³ 3,892	12,499	⁶ 10,000	12,321
Ferrosilicon	49,044	³ 50,802	39,478	50,096	50,747
Other	53	284	⁶ 500	⁶ 500	529
Steel, crude:					
Steel ingots thousand tons	10,216	³ 10,261	10,962	11,332	12,605
Steel castings do	89	³ 84	92	95	146
Total do	10,305	³ 10,345	11,054	11,427	12,751
Semimanufactures ⁴ do	⁶ 5,511	³ 6,967	³ 7,841	7,753	9,790
Lead:					
Mine output, Pb content	25,700	24,839	27,085	37,578	⁶ 36,725
Metal, refined:					
Primary	14,960	15,246	15,567	19,933	20,669
Secondary	6,596	⁶ 10,000	⁶ 10,000	11,300	9,797
Total	21,556	³ 25,246	³ 25,567	31,233	30,466
Manganese:					
Ore and concentrate, gross weight thousand tons	1,281	1,130	1,240	1,213	1,275
Mn content	480,811	420,812	461,776	455,287	478,600
Rare-earth metals: Monazite concentrate, gross weight ⁶	4,000	4,000	4,000	4,000	4,000
Selenium kilograms	3,684	4,191	4,850	⁷ ⁴ 4,800	4,026
Silver, mine and smelter output thousand troy ounces	469	862	816	1,134	1,220
Titanium concentrates, gross weight:					
Ilmenite	³ 134,476	⁶ 140,000	³ 143,000	⁶ 140,000	⁶ 140,000
Rutile	³ 5,500	⁶ 6,000	³ 6,800	⁶ 7,000	⁶ 7,000
Tungsten, mine output, W content	15	21	28	23	26
Zinc:					
Mine output, concentrate:					
Gross weight	77,594	85,260	87,082	94,597	102,661
Zn content	40,350	44,335	45,283	49,198	53,384
Metal:					
Primary	53,268	55,753	70,947	⁶ 72,000	68,899
Secondary ⁵	200	200	200	200	200
Total	53,468	55,953	71,147	⁶ 72,200	69,099
Zirconium concentrate: Zircon, gross weight	11,395	⁶ 12,000	14,800	⁶ 16,000	⁶ 16,000
INDUSTRIAL MINERALS					
Abrasives, natural, n.e.s.:	714	442	498	968	496
Corundum, natural		⁶ 3,000	5,917	5,366	⁶ 6,801
Garnet	3,349	⁶ 5,000	5,078	2,426	3,745
Jasper	5,418	25,450	30,183	25,236	27,019
Asbestos	24,873				

See footnotes at end of table.

Table 1.—India: Production of mineral commodities¹—Continued

(Metric tons unless otherwise specified)

Commodity ²	1983	1984	1985	1986	1987 ³
INDUSTRIAL MINERALS—Continued					
Barite	323,000	446,000	579,742	344,000	211,726
Bromine, elemental ⁴	350	350	350	350	350
Cement, hydraulic	25,356	29,030	33,050	36,400	36,980
Chalk	91,146	*80,000	114,964	106,708	95,156
Clays:					
Ball clay	137,917	*135,000	236,625	277,460	252,019
Diaspore	6,361	*6,000	9,605	11,580	10,983
Fire clay	657,000	602,000	592,047	583,000	554,824
Kaolin:					
Direct salable, crude	553	504	585	733	695
Processed	*100	116	*110	*100	*150
Total	653	620	695	833	845
Other ⁵	80	80	100	100	100
Diamond:					
Gem ⁶	12	13	14	13	16
Industrial ⁶	2	2	2	*3	3
Total	14	15	16	16	19
Feldspar	41,837	39,943	46,101	46,288	49,663
Fluorspar:					
Concentrates:					
Acid-grade	*11,000	*12,000	11,107	*7,624	*8,261
Metallurgical-grade	4,590	*5,000	*5,000	*4,109	*4,448
Total	*15,590	*17,000	*16,107	11,733	12,709
Other fluorspar materials, graded	6,993	4,232	*4,000	6,841	5,748
Gem stones excluding diamond:					
Agate including chalcedony pebble	502	*1,000	750	776	752
Garnet	735	*2,000	2,399	5,021	2,007
Graphite ⁶	39,567	38,986	27,337	38,412	26,864
Gypsum	1,039,000	1,378,000	1,260,369	1,549,000	1,861,000
Kyanite and related materials:					
Andalusite	2,573	2,700	504	732	482
Kyanite	38,307	37,024	30,472	32,394	37,382
Sillimanite	7,928	13,377	17,095	14,905	14,366
Lime ⁶	400,000	500,000	500,000	600,000	700,000
Magnesite	434,072	414,029	417,412	422,000	419,333
Mica: ⁷					
Exports:					
Block	1,100	1,100	1,200	1,200	1,200
Film and book for mica cuttings	200	200	250	250	250
Splittings	3,000	3,000	4,000	4,000	4,000
Scrap	7,000	7,000	11,000	11,000	11,000
Powder	4,000	4,000	4,700	4,700	4,700
Manufactured	500	500	1,000	1,000	1,000
Total	15,800	15,800	22,150	22,150	22,150
Domestic use, all forms	3,000	3,000	3,500	3,500	4,000
Total mica	18,800	18,800	25,650	25,650	26,150
Nitrogen: N content of ammonia ⁸					
Phosphate rock including apatite	3,565	3,975	4,324	5,410	4,742
Fugments, mineral, natural: Ocher	687,907	892,000	929,098	667,070	679,419
Pyrites, gross weight	88,633	107,852	108,549	98,668	145,245
Total	63,621	44,238	17,744	20,773	29,486
Salt:					
Rock salt	4	5	4	2	1
Other	7,008	7,723	9,875	10,116	9,900
Total	7,012	7,728	9,879	10,118	9,901
Sodium carbonate	744,329	830,863	813,600	873,600	969,600
Stone, sand and gravel ⁹					
Calcite	*20,000	*20,000	26,049	26,318	36,282
Dolomite	2,264	2,277	2,217	2,139	2,178
Limestone	36,965	45,483	48,070	52,562	56,680
Quartz and quartzite	*300	*300	259	274	227
Sand:					
Calcareous	598	570	706	571	112
Other	1,018	*1,200	2,349	1,113	1,761
Slate	3,461	*5,000	5,529	6,483	2,312

See footnotes at end of table.

Table 1.—India: Production of mineral commodities¹—Continued

(Metric tons unless otherwise specified)

Commodity ²	1983	1984	1985	1986	1987 ³
INDUSTRIAL MINERALS—Continued					
Sulfur:					
Content of pyrites	25,448	17,695	7,098	8,309	11,794
Byproduct:					
From metallurgical plants ⁴	119,000	115,000	120,000	120,000	120,000
From oil refineries	3,906	*5,000	305	*1,000	—
Total ⁵	139,354	137,695	127,403	129,309	131,794
Talc and related materials:					
Pyrophyllite	59,042	84,159	53,741	53,005	51,724
Steatite (soapstone)	294,900	333,576	329,192	343,000	359,448
Vermiculite	2,411	1,953	1,805	6,681	2,439
Wollastonite	16,557	*20,000	26,040	23,770	31,021
MINERAL FUELS AND RELATED MATERIALS					
Coal:					
Bituminous	thousand tons	136,261	145,800	149,259	162,800
Lignite	do.	7,342	7,500	7,774	7,900
Total	do.	143,603	153,300	157,033	170,700
Coke: ⁶					
Coke oven and beehive	do.	12,000	12,000	13,000	13,000
Gashouse	do.	100	100	100	100
Other, soft	do.	50	50	100	200
Total	do.	12,150	12,150	13,200	13,300
Gas, natural:					
Gross	million cubic feet	210,550	255,700	287,200	*360,000
Marketable ⁷	do.	100,860	114,420	133,561	232,090
Petroleum:					
Crude	thousand 42-gallon barrels	184,440	204,943	219,132	228,416
Refinery products:					
Gasoline	do.	27,100	*26,000	† *34,000	*42,000
Kerosene and jet fuel	do.	27,900	*27,000	† *38,000	*45,000
Distillate fuel oil	do.	87,200	*84,000	† *95,000	*110,000
Residual fuel oil	do.	53,600	*51,000	† *63,000	*58,000
Lubricants	do.	3,200	*3,000	† *3,000	*3,000
Other	do.	43,600	*42,000	† *50,000	*55,000
Refinery fuel and losses	do.	20,200	*19,000	† *28,800	*21,660
Total	do.	262,800	*252,000	† *305,800	† *334,660

¹Estimated. ²Preliminary. ³Revised.⁴Table includes data available through Sept. 15, 1988.

⁵In addition to the commodities listed, other clays (bentonite, common clay, and fuller's earth), other gem stones (aquamarine, ruby, and spinel), and uranium are also produced, but output is not reported, and available information is inadequate to make reliable estimates of output levels. In 1975, production of 6,514 metric tons of uranium ore containing about 3 metric tons of U₃O₈ was reported from two mines, which was only a part of total national production. Reported production values for sand and gravel and stone are clearly only partial figures and exclude a number of types of stone; the amounts reported are inadequate to provide sufficient aggregate for production of concrete from domestically produced and consumed cement, and they provide for other supplies of aggregate for road metal and other construction uses.

⁶Data are for fiscal year beginning Apr. 1 of that stated.⁷Excludes production from steel miniplants.

⁸Official Indian Bureau of Mines figure is thought to be production from Government-owned operations. Private Indian production brings 1987 total to more than 20,000 tons.

⁹India's marketable production is 10% to 20% of mine production.

¹⁰Data supplied here (exports plus domestic use) are provided in lieu of officially reported production because the latter figures are evidently incomplete. Officially reported production figures are as follows, in metric tons: 1983—7,364; 1984—7,171; 1985—6,965; 1986—4,684; and 1987—4,240.

¹¹Partial figures; for details, see footnote 2.¹²Includes reinjected gas.

TRADE

In FY 1984, the most recent year for which detailed trade statistics are available, the value of mineral exports was \$2.85 billion, or 29% of merchandise trade. The

value of mineral exports increased strongly during FY 1981-83. In FY 1984, exports, by value, of crude oil, cut and polished diamonds, iron ore, building and monument

stone, mica, chromite, manganese ore, other gem stones, barite, alumina, and emeralds accounted for 97% of the value of mineral exports. In FY 1987, diamond had the highest value of mineral exports. Crude oil had been exported because Indian refineries were unable to refine Bombay High oil. All Indian refineries have now been modified to process Bombay High oil; consequently, crude oil exports were estimated to have dropped to a low level. Emerald production was also thought to have declined to an insignificant level. Modern cutting and polishing equipment has been introduced into some marble and granite quarries, which has probably increased production volume and value. With completion of the NALCO project, exports of alumina should show a large increase beginning in 1988.

Minerals were exported to 88 countries in FY 1984. The major recipients of these minerals, excluding petroleum, were the United States, 31%; Japan, 29%; Belgium, 8%; and Hong Kong, 7%. Others receiving 2% to 4% of India's exports were Italy, the Republic of Korea, Romania, Singapore, Switzerland, and the U.S.S.R.

Exports of metals and alloys accounted for 1% of India's export trade value. Iron and steel, including scrap, made up 80%

of these exports, followed by aluminum and copper, mainly as brass and bronze.

Imported minerals, 29% of India's imports, were valued at \$4.2 billion in FY 1984. Crude petroleum accounted for 69% of imported minerals; rough diamond, 20%; sulfur 4%; and rock phosphate, 3%. Saudi Arabia was India's principal mineral importer at 24%, followed by the U.S.S.R., 16%; Iraq, 14%; and Belgium, 11%.

Imports of metals and alloys were valued at \$1.29 billion or 9% of India's imports. Iron and steel, including scrap, accounted for 65%; copper, 9%; aluminum, 7%; zinc, 5%; and ferroalloys and nickel, 4% each.* Imports of metals and alloys have tended to vary considerably because production losses caused by inadequate electric power were generally offset by imports.

In light of increased domestic production, imports of steel dropped from 2.2 million tons in FY 1986 to 1.9 million tons in FY 1987. The major categories of those imports in FY 1987 were skelp, hot- and cold-rolled coil and sheet, and tin mill black plate. Here again, the steel import mix varied considerably as semimanufactures, structurals, plates, and stainless and alloy steels dropped precipitously from FY 1986 levels.

Table 2.—India: Exports of mineral commodities¹

(Metric tons unless otherwise specified)

Commodity	1983-84	1984-85	Destinations, 1984-85	
			United States	Other (principal)
METALS				
Aluminum:				
Ore and concentrate	118,867	61,547	--	United Arab Emirates 44,547; Saudi Arabia 17,000.
Oxides and hydroxides	37,805	49,474	--	U.S.S.R. 48,993; Japan 430.
Metal including alloys, all forms	6,916	5,598	249	U.S.S.R. 3,408; Bangladesh 758.
Cadmium: Metal including alloys, all forms	--	12	--	All to United Arab Emirates.
Chromium:				
Ore and concentrate	103,386	238,387	--	Japan 208,387; Philippines 15,500.
Metal including alloys, all forms	7,604	--	--	--
Copper:				
Ore and concentrate	17	18,746	--	West Germany 9,715; Republic of Korea 9,031.
Metal including alloys, all forms	1,353	1,325	68	Iran 661; U.S.S.R. 342.
Iron and steel:				
Iron ore and concentrate including roasted pyrite thousand tons	22,073	25,527	NA	Japan 16,254; Romania 3,403; Republic of Korea 3,015.
Metal:				
Scrap	57,615	52,449	NA	Philippines 25,137; Japan 25,096.
Pig iron, cast iron, related materials	695	1,466	1,030	Oman 222; Nigeria 80.
Ferroalloys:				
Ferromanganese	--	1,950	--	All to Netherlands.
Silicon metal	2	8	--	All to United Kingdom.
Unspecified	--	42	--	NA.
Steel, primary forms	97,535	197,103	27,212	U.S.S.R. 75,629; Saudi Arabia 23,838; China 18,050.

See footnotes at end of table.

Table 2.—India: Exports of mineral commodities¹—Continued

(Metric tons unless otherwise specified)

Commodity	1983-84	1984-85	Destinations, 1984-85	
			United States	Other (principal)
METALS -Continued				
Lead: Metal including alloys, all forms	5	65	--	Bangladesh 52.
Manganese:				
Ore and concentrate, metallurgical-grade	358,442	621,432	--	Japan 306,256; Republic of Korea 101,101; Romania 73,147.
Oxides	214	204	--	Sri Lanka 164; France 22.
Metal including alloys, all forms	2	10	--	All to Thailand.
Nickel: Metal including alloys, all forms	10	76	--	U.S.S.R. 62; Oman 8.
Selenium, elemental	28	18	--	Hungary 10; Sri Lanka 4.
Tin:				
Ore and concentrate	--	50	--	All to Malaysia.
Metal including alloys, all forms	415	607	--	Nepal 117; United Kingdom 98; Kenya 83.
Titanium:				
Ore and concentrate	176,111	125,131	--	Japan 34,735; West Germany 29,332; France 28,100.
Oxides	20	--	--	
Tungsten: Metal including alloys, all forms	(2)	4	--	All to Bangladesh.
Vanadium: Ore and concentrate ^a	54	202	--	West Germany 200.
Zinc: Metal including alloys, all forms	127	36	--	Belgium-Luxembourg 17; Sri Lanka 8.
INDUSTRIAL MINERALS				
Abrasives, n.e.s.: Natural: Corundum, emery, pumice, etc.	647	1,127	NA	NA.
Asbestos, crude	79	158	--	West Germany 68; Czechoslovakia 44.
Barite and witherite	120,580	347,317	248,001	United Arab Emirates 76,549; U.S.S.R. 10,000.
Boron materials:				
Sodium borate	537	279	--	Singapore 140; Sri Lanka 27.
Oxides and acids	13	34	--	Netherlands 15; Bangladesh 11.
Cement	8,505	21,543	NA	Nepal 6,629; unspecified 14,914.
Chalk	91	73	--	Bangladesh 62.
Clays, crude:				
Bentonite	21,079	69,170	--	United Arab Emirates 34,356; Kuwait 17,463.
Fire clay	471	1,100	--	U.S.S.R. 500; Kenya 283; Bangladesh 200.
Kaolin	5,664	5,307	--	Bangladesh 3,728; Syria 800; Japan 650.
Unspecified	452	596	31	Sweden 210; Bangladesh 189.
Diamond: Gem, not set or strung value, thousands	\$1,135,779	\$955,236	\$451,169	Japan \$131,847; Belgium-Luxembourg \$122,032.
Feldspar	14,569	37,689	--	Bangladesh 19,543; Malaysia 7,375; Taiwan 4,089.
Graphite, natural	1,188	1,876	531	Japan 334; Singapore 264; Taiwan 250.
Gypsum and plaster	519	18,565	--	Sri Lanka 18,101; Nepal 464.
Kyanite and related materials: Sillimanite	150	--	--	
Magnesium compounds: Oxides and hydroxides	1,447	3,030	--	United Kingdom 2,214; Japan 816.
Mica:				
Crude including splittings and waste	12,430	16,430	4,606	Japan 2,970; Belgium-Luxembourg 2,456.
Worked including agglomerated splittings	13,076	13,125	1,180	Norway 2,291; West Germany 2,216; Japan 1,709.
Phosphorus, elemental	58	54	--	All to Nepal.
Pigments, mineral:				
Natural, crude	78	360	--	Philippines 142; West Germany 76.
Iron oxides and hydroxides, processed	3,649	5,190	--	Philippines 1,367; United Kingdom 861; Kenya 641.
Precious and semiprecious stones other than diamond: Natural:				
Emerald value, thousands	\$3,615	\$2,940	\$656	Singapore \$843; Switzerland \$432.
Other do.	\$23,865	\$12,454	\$3,931	Hong Kong \$1,349; Japan \$872; Switzerland \$820.
Salt and brine	116,221	29,684	--	Bangladesh 20,220; Singapore 7,500.
Sodium compounds, n.e.s.: Carbonate, manufactured	148	7	NA	NA.
Stone, sand and gravel:				
Dimension stone, all forms	379,943	489,155	2,435	Japan 203,628; Italy 139,925.
Dolomite, chiefly refractory-grade	3,835	2,142	--	Bangladesh 2,098.
Limestone other than dimension	105,917	187,255	NA	Bangladesh 175,678.
Quartz and quartzite	28,382	53,784	--	Japan 51,910; Bangladesh 1,749.
Sand other than metal-bearing	7,349	9,075	--	Japan 4,831; United Arab Emirates 2,657.

See footnotes at end of table.

Table 2.—India: Exports of mineral commodities¹—Continued

(Metric tons unless otherwise specified)

Commodity	1983-84	1984-85	Destinations, 1984-85	
			United States	Other (principal)
INDUSTRIAL MINERALS --Continued				
Sulfur: Elemental, crude including native and byproduct	---	22	---	All to Nepal.
Talc, steatite, soapstone, pyrophyllite	9,635	12,563	NA	Kenya 2,839; Norway 2,810; Bangladesh 1,087.
Vermiculite	2,874	465	---	Kuwait 200; Japan 102; Sri Lanka 100.
MINERAL FUELS AND RELATED MATERIALS				
Coal, all grades including briquets	---	---	---	Bangladesh 52; Nepal 48.
Coke and semicoke	44	353	---	All to Nepal.
Petroleum:	---	---	---	---
Crude, thousand 42-gallon barrels	41,989	48,203	NA	NA.
Refinery products: ⁴	---	---	---	---
Light distillates:	---	---	---	---
Naphtha	7,658	5,202	NA	NA.
Other	110	119	NA	NA.
Middle distillates	821	985	NA	NA.
Heavy ends	2,984	1,166	NA	NA.

NA Not available.

¹Table prepared by Audrey D. Wilkes. Data are for Indian fiscal year Apr. 1 through Mar. 31. Data in this table have been compiled from the Indian Minerals Yearbook 1986.²Less than 1/2 unit.³May include other unspecified ores.⁴Defined as provided in data source.Table 3.—India: Imports of mineral commodities¹

(Metric tons unless otherwise specified)

Commodity	1983-84	1984-85	Sources, 1984-85	
			United States	Other (principal)
METALS				
Aluminum:				
Oxides and hydroxides	1,015	971	23	France 409; West Germany 212; Netherlands 167.
Metal including alloys, all forms	26,326	61,794	2,040	Bahrain 20,426; U.S.S.R. 9,781; United Arab Emirates 7,322.
Antimony:				
Ore and concentrate	--	103	--	All from Thailand.
Metal including alloys, all forms	511	352	--	China 271; Taiwan 50.
Arsenic: Oxides and acids	39	5	NA	NA.
Cadmium: Metal including alloys, all forms	113	20	--	Australia 18.
Chromium:				
Ore and concentrate	36	--	--	United Kingdom 69.
Metal including alloys, all forms	49	73	--	Zaire 53; Belgium-Luxembourg 16; Zambia 16.
Cobalt: Metal including alloys, all forms	155	116	4	Zambia 16.
Copper: Metal including alloys, all forms	120,854	80,138	2,559	Zambia 29,513; Zaire 6,588; Japan 5,947.
Iron and steel:				
Iron ore and concentrate including roasted pyrite	52	--	--	--
Metal:				
Scrap	802,453	618,646	205,472	Netherlands 148,148; West Germany 109,683.
Pig iron, cast iron, related materials	315,207	3,546	--	Japan 2,550; Canada 361; Brazil 321.
Ferroalloys:				
Ferrosilicon	18,841	9,172	85	West Germany 6,523; Sweden 1,723.
Ferromanganese	1,350	811	--	West Germany 520; France 158.
Ferromolybdenum	5	10	2	United Kingdom 6.
Ferroinickel	18,860	19,036	1,378	Colombia 3,885; France 3,041; New Caledonia 2,498.
Ferrosilicochromium	10	5	--	All from West Germany.
Ferrosilicomanganese	413	--	--	--
Ferrosilicon	368	129	5	France 64; United Kingdom 40.
Silicon metal	1,374	1,387	28	France 446; Norway 407; Canada 157.
Unspecified	66	5	--	All from United Kingdom.
Steel, primary forms	2,114,430	1,842,312	31,309	Japan 508,777; West Germany 454,639.

See footnotes at end of table

Table 3.—India: Imports of mineral commodities¹—Continued

(Metric tons unless otherwise specified)

Commodity	1983-84	1984-85	Sources, 1984-85	
			United States	Other (principal)
METALS—Continued				
Lead:				
Ore and concentrate	2,957	10,097	--	Canada 7,177; Belgium-Luxembourg 2,362.
Metal including alloys, all forms	43,338	42,902	NA	Australia 32,595; Netherlands 5,009.
Magnesium: Metal including alloys, all forms	563	634	63	Norway 368; France 143.
Manganese:				
Ore and concentrate:				
Battery-grade	973	106	--	All from Singapore.
Metallurgical-grade	2,790	3,841	--	Singapore 2,516; Gabon 1,205.
Oxides	454	285	10	Japan 181; Belgium-Luxembourg 94.
Metal including alloys, all forms	811	217	18	France 70; China 61.
Molybdenum: Metal including alloys, all forms	23	5	1	Austria 2; Netherlands 2.
Nickel:				
Ore and concentrate	2,215	1,589	95	Cuba 700; Canada 292; Netherlands 192.
Metal including alloys, all forms	11,304	11,881	726	U.S.S.R. 2,387; Norway 1,671; Canada 1,095.
Platinum-group metals: Metals including alloys, unwrought and partly wrought troy ounces	5,787	6,044	--	U.S.S.R. 3,568; United Kingdom 2,476.
Selenium, elemental	12	2	--	Bulgaria 1; Japan 1.
Silver: Metal including alloys, unwrought and partly wrought troy ounces	37,745	8,584	161	West Germany 5,530; Switzerland 1,093.
Tin:				
Ore and concentrate	1	--	--	--
Metal including alloys, all forms	7,050	17,187	1,423	United Kingdom 7,358; France 1,996.
Titanium:				
Ore and concentrate	45	229	--	Sri Lanka 200.
Oxides	14,445	10,376	4,017	United Kingdom 2,123; West Germany 1,129.
Tungsten:				
Ore and concentrate	522	212	--	Burma 128; Norway 40.
Metal including alloys, all forms	41	22	4	Belgium-Luxembourg 6; Japan 6.
Vanadium: Ore and concentrate ²	498	604	42	United Kingdom 248; West Germany 117; Canada 60.
Zinc:				
Ore and concentrate	11,784	4,955	72	Australia 4,817.
Metal including alloys, all forms	81,022	63,887	1,269	Zambia 10,233; Finland 8,602; Zaire 6,980.
INDUSTRIAL MINERALS				
Abrasives, n.e.s.: Natural: Corundum, emery, pumice, etc	NA	10	NA	NA.
Asbestos, crude	87,264	68,827	--	Canada 38,971; U.S.S.R. 16,914; Brazil 4,919.
Boron materials: Crude natural borates	26,179	11,813	5,889	Turkey 5,810.
Cement	1,548,378	267,812	6,860	Romania 134,847; Poland 40,794.
Clays, crude:				
Bentonite	57	12	--	Mainly from United Kingdom.
Kaolin	54	107	4	United Kingdom 102.
Unspecified	1,324	1,141	322	United Kingdom 402; Japan 200.
Diamond:				
Gem, not set or strung value, thousands	\$1,040,360	\$855,313	NA	Belgium-Luxembourg \$465,696; United Kingdom \$285,491.
Industrial stones do	\$872	\$197	\$25	Belgium-Luxembourg \$90; United Kingdom \$37.
Diatomite and other infusorial earth	106	8	8	--
Fertilizer materials: Manufactured:				
Phosphatic ³	142,600	745,200	NA	NA.
Potassic	701,937	1,030,853	16,521	Canada 422,917; West Germany 369,824.
Fluorspar	20,643	12,824	--	Thailand 11,918; China 449.
Graphite, natural	520	245	1	Sri Lanka 108; Japan 60.
Gypsum and plaster	--	9	9	--
Magnesium compounds:				
Magnesite, crude	37	2	--	Mainly from Netherlands.
Oxides and hydroxides	16,077	4,805	--	United Kingdom 2,082; Japan 1,235; Netherlands 1,094.

See footnotes at end of table.

Table 3.—India: Imports of mineral commodities¹—Continued

(Metric tons unless otherwise specified)

Commodity	1983-84	1984-85	Sources, 1984-85	
			United States	Other (principal)
INDUSTRIAL MINERALS —Continued				
Mica:				
Crude including splittings and waste	--	3	--	All from United Kingdom.
Worked including agglomerated splittings	36	12	--	Switzerland 7; United Kingdom 2.
Phosphates, crude ————— thousand tons	1,440	1,593	339	Jordan 848; Morocco 268.
Phosphorus, elemental	7	96	--	Netherlands 90.
Pigments, mineral:				
Natural, crude	2	19	19	
Iron oxides and hydroxides, processed	213	370	51	United Arab Emirates 200; West Germany 95.
Potassium salts, crude	6,500	13,000	--	All from West Germany.
Precious and semiprecious stones other than diamond: Natural:				
Emerald ————— value, thousands	\$10,709	\$7,577	\$2,303	Switzerland \$1,222; Hong Kong \$871.
Other ————— do. —————	\$4,457	\$1,756	\$273	Singapore \$506; Brazil \$267.
Salt and brine	7,111	7,353	--	Pakistan 7,295.
Stone, sand and gravel:				
Dimension stone, all forms	2,530	60,395	--	Italy 59,003.
Quartz and quartzite	26	NA	--	
Sand other than metal-bearing	3,479	2,016	179	Australia 757; Singapore 468; Sri Lanka 261.
Sulfur: Elemental:				
Crude including native and byproduct	808,423	1,153,089	89,342	Canada 546,530; Saudi Arabia 300,612.
Colloidal, precipitated, sublimed	118	221	120	France 72.
Talc steatite, soapstone, pyrophyllite	22	15	--	All from Nepal.
MINERAL FUELS AND RELATED MATERIALS				
Coal, all grades including briquets	360,605	543,177	--	Mainly from Australia.
Coke and semicoke	115	17,165	--	Australia 16,500; Japan 662.
Petroleum, crude				
thousand 42-gallon barrels	117,888	98,436	--	Saudi Arabia 33,204; U.S.S.R. 22,881; Iraq 19,780.

NA Not available.

¹Table prepared by Audrey D. Wilkes. Data are for Indian fiscal year Apr. 1 through Mar. 31. Data in this table have been compiled from the Indian Minerals Yearbook 1986.²May include other unspecified ores.³P₂O₅ content. Data from The Fertiliser Association of India, New Delhi. Fertiliser Statistics, 1984-85, p. I-190.

COMMODITY REVIEW

METALS

Aluminum and Bauxite.—The Reserve Bank of India approved the U.S.-based Kaiser Aluminum and Chemical Corp.'s proposal to withdraw its 26% equity from the private sector Hindustan Aluminium Corp. (HINDALCO). HINDALCO, incorporated 25 years ago, is a part of the Birla Group. Kaiser owned 3.57 million shares of the company and proposed to offer them to the other shareholders at less than one-half the market price. The Indian Government's tight controls on aluminum distribution and pricing appeared to have prompted Kaiser's withdrawal. Kaiser had been considering such a move for a number of years.

Bharat Aluminium Co. Ltd.'s (BALCO) captive powerplant began to generate electricity during 1987. Three 67.5-megawatt turbogenerators were brought on-line in

June, September, and November. The fourth unit had fallen behind schedule and was to be brought on-line in spring 1988. The cost of the powerplant escalated from \$259 million in August 1985 to \$400 million. Critical power shortages have severely cut BALCO's aluminum production for many years.

The committee studying the ecology and environmental effects of the long-delayed Gandhamardan bauxite mine submitted a favorable report to the Department of Environment in January 1987. The Department of Environment gave conditional clearance for the project in October, pending final approval by an Environmental Management Authority formed for the purpose. The 5-year delay has caused the cost of the project to double to more than \$50 million.

The completion of this fully mechanized 600,000-ton-per-year mine has been delayed

by land acquisition problems, environmental concerns, and agitation by local residents. Any further delays will adversely affect BALCO's operations. Reserves at the company's mines at Amarkantak and Phutkaphar in Madhya Pradesh were expected to be exhausted by 1990.

The feasibility study by the Soviet agency Tsvetromoexport on the Andhra Pradesh bauxite mine was submitted to the Steel and Mines Minister and was awaiting action. The mine was to have a capacity of 2.3 million tons per year. An agreement was signed in Moscow between NALCO and the Institute of Aluminum, Magnesium, and Electrode Industry of Leningrad. It provided for the use of Soviet equipment and credit once approved by the Indian Government. The bulk of the ore would be exported to the U.S.S.R.

The giant NALCO complex in Orissa continued shakedown operations as each major component was brought into commercial production. Production at the \$68 million mine was being increased slowly to its 2.4-million-ton capacity. The reserves of more than 317 million tons were deemed to be recoverable as the overburden is only 1 meter thick.

The second-phase production line at the \$585 million Damanjodi alumina plant was commissioned. The work force at Damanjodi was 800, of which 100 were management and office staff. The plant had 51 megawatts of captive power installed at a cost of \$115 million. By May 1987 the plant had produced 126,000 tons of alumina, of which 85,000 tons had been exported. NALCO planned to export 375,000 tons per year from the Visakhapatnam port with the remaining 425,000 tons going to its Angul smelter. The smelter's first potline was tested in March and began commercial production in April. The \$554 million smelter was rescheduled to attain its full capacity of 218,000 tons in 1989 and would employ 3,500 workers. The smelter was still in the shakedown phase. Production for the first 11 months was 20,000 tons of ingot. Energy consumption, reportedly, was highly efficient at 13,000 to 13,400 kilowatt hours per ton of metal. The smelter and powerplant are at the coal rather than the bauxite supply mine site. In this case, the coal for generating the required 600 megawatts is of poor quality, averaging 43% ash. Shipping lower tonnages of alumina to Angul was considered much more economical.

The powerplant and coal mine were major costs and key features of the NALCO

project. The powerplant was estimated to cost \$623 million. It employed 900 workers and would employ 1,100 when all of the generators are installed. Five 120-megawatt generators were authorized and an application for a sixth was submitted for approval to the Government. The first generator was constructed in the Federal Republic of Germany. About 50% of the second generator was manufactured in the Federal Republic of Germany with the remainder finished in India. Both of these units were installed by yearend. The No. 4 and No. 5 units were being constructed entirely in India but the controls were purchased from the Federal Republic of Germany. The plant required four units for normal operation, with the fifth used as a backup. The plant managers were fearful, however, that frequent power outages in Orissa would cause the local government to pressure them to provide power for other uses. The powerplant is served by a captive railroad which delivers 1,800 tons per day of coal for each generator. The NALCO complex was the only aluminum plant in India to be totally independent for its raw material and power needs. At yearend, NALCO was granted a license for a 30,000-ton-per-year aluminum-alloy wire plant at Angul.

A new 200,000-ton-per-year smelter was being planned for Sindri in Bihar State. The plant would be a downstream development of the Mukunda Coalfield development program in Dhanbad District, which was being set up under a Indo-Soviet agreement. The coalfield, electric powerplants, bauxite mine, and aluminum plants would be an economic stimulus to this underdeveloped area.

Chromite.—OMC Alloys Ltd., a subsidiary of Orissa Mining Corp. Ltd., began operating its pellet roasting kiln in April. Orissa Mining planned to construct India's third chromite beneficiation plant in South Kaliapani, the second such plant in Orissa. It also planned to build a briquetting plant. The 84,000-ton-per-year beneficiation plant would process low-grade ore of less than 50% Cr_2O_3 , and the briquetting plant would process high-grade ore. The briquetting plant was to produce 50,000 tons per year and feed several local ferrochromium plants. Completion of both plants was scheduled for 1989. These plants are part of India's trend to produce higher value ferrochromium for export.

Tata Iron and Steel Co. Ltd. (TISCO) started expansion of its Sukinda chromite mine and installation of a plant to treat

low-grade ore. The plant feed was to average 20% Cr_2O_3 and the product about 50% Cr_2O_3 . Plant equipment was to be supplied by Sala International of Sweden and Mineral Deposits Ltd. of Australia.

Indian Metals and Ferro Alloys Corp. Ltd. (IMFA) continued construction of the 50,000-ton-per-year Indian Charge Chrome Ltd. (ICCL) charge chrome plant and a 108-megawatt coal-fired powerplant. ICCL expected to complete the plants in late 1988. IMFA had ferrochromium plants at Therubali and Choudhar. The Therubali plant produced ferrochromium for domestic consumption and the Choudhar plant was closed pending adequate power supply.

Ferro Alloys Corp. Ltd.'s ferrochromium plant at Shreeramnagar in Andhra Pradesh was subjected to a 40% electric power reduction during 1987 because of regional drought.

Copper.—The modernization program begun in 1986 at Khetri Copper Complex (KCC) was continued. The waste heat boiler was restored to its original capacity after modification and repair. The replacement of the refractory lining of the flash furnace and modification of the second anode furnace were under way. Installation of a new type of sulfur burner in the off-gas recovery plant was completed.

The Mosaboni Mine at the Indian Copper Complex (ICC) in Singhbhum District, Bihar, was being expanded from 50,000 to 80,000 tons per month at a revised cost of more than \$6 million. The Kendadih Mine, which started out as an exploratory working, was being expanded to a capacity of 400 tons per day. It was also decided to develop the Chhapri and Sidheswari Mines and eventually to replace an old uneconomic mine with these new mines. To offset continuing power supply problems, HCL was adding another 4.4-megawatt turbogenerator to bring total captive power at ICC to 22.8 megawatts.

India's objective of substantially increasing copper production depends upon a huge expansion of the Malanjkhand Mine. The Japanese Government has offered substantial financial aid through its Overseas Economic Cooperation Fund to cover engineering services. The loan would allow Japan's mining and engineering firms to compete for a feasibility report, which should be completed by early 1990. The plan is to expand the 2-million-ton-per-year ore capacity to between 14 and 16 million tons per year, thus yielding a copper content of more than 100,000 tons.

HCL also planned to construct a natural gas-fueled continuous-cast copper wire rod plant at Taloja, Maharashtra. It is to have an annual capacity of 60,000 tons and is estimated to cost \$14 million. Southwire Technology Inc. of the United States has reportedly received a letter of intent to build the plant and to supply the machinery and technology. India's annual demand for copper metal was 125,000 tons, leaving a shortage of 85,000 tons that must be imported. Prospects for reducing imports were minimal, barring the discovery of a large high-grade deposit. Minerals and Metals Trading Corp. (MMTC) supervised imports of copper as nearly 90% was routed through it, with the balance imported by a few authorized companies that use copper to manufacture products for export. MMTC was authorized to import 80,000 tons of copper in FY 1988.

India's projected demand for copper is 150,000 tons for FY 1989, increasing to 200,000 tons by FY 2000. Domestic production in FY 1989 and FY 2000 was projected to be 60,000 tons and 75,000 tons, respectively. The increase was to come mostly from the Malanjkhand Mine expansion and from marginal increases at the Bihar and Rajasthan Mines.

Iron and Steel.—India's demand for steel has been rising erratically but constantly for years. The industry suffers from various cultural, financial, political, and technical problems. The Government-owned Steel Authority of India Ltd. (SAIL) was in the middle of a huge modernization and expansion program while trying to resolve the problems. The major problems were as follows: (1) a chronic instability of domestic demand, (2) poor quality of raw materials, especially coal, which lowered the quality and increased the cost of steel production, (3) chronic electric-power shortages, and (4) excessive work force, which further increased costs. In addition, the public sector plants under SAIL suffered from old technology and equipment, high energy consumption, inefficient management, and an inability to adjust the product mix or rolling mill programs in response to changes in demand.*

The shortage of electric power at SAIL steel plants between April 1986 and June 1987 has caused the loss of over 500,000 tons of crude steel. To help insulate SAIL plants against power shortfalls, the Government approved additional captive power facilities at Bokaro, Durgapur and Rourkela. When completed, about two-thirds of SAIL's pow-

er requirements will be met by captive powerplants, which is double the previous amount. TISCO had captive power of 132 megawatts and planned to increase this by 60 megawatts by 1988. It further proposed to add 120 megawatts of captive power to meet the demand of producing an additional 1 million tons of steel by 1990.

As of March 1986, the work force of SAIL was 208,000. About 50,000 surplus workers who cannot be laid off because of labor rules were expected to retire within 10 years; meanwhile, SAIL will continue to have excessive labor costs. TISCO, also having surplus workers, planned to retrain and reassign them to new facilities. The voluntary retirement schemes of SAIL and TISCO have been unsuccessful to date.

Differences in technology, maintenance programs, and management had led to different rates of capacity utilization (RCU) and profits for SAIL and TISCO plants that have capacities of 7.2 and 1.7 million tons per year of salable steel respectively. The Government exempted SAIL from contributing to the Steel Development Fund, a statutory obligation, and waived interest on its Government loans. Despite this, SAIL, with an RCU of 83% in FY 1986, declared a profit of \$93 million. In contrast, privately owned TISCO, a much smaller company, operated at an RCU of 109%, earning a profit of \$79 million in FY 1986. Both company's profits were sharply lower than those of FY 1985 because of a steep rise in input costs of raw materials, supplies, and energy.

Steel prices in India have not increased since February 1985. But, according to industry estimates, production costs have gone up \$44 to \$51 per ton of raw steel. Since then costs have increased for power, 14%; coal, 33%; and railway transportation, 37%. Wage rates costs were also expected to go up. The rates were being negotiated at yearend with the results to be retroactive to September 1, 1986.

SAIL's priority was to accelerate the application of new technology in its existing plants and to raise production from 6.3 million tons in FY 1986 to 15 million tons by FY 2000. The expansions of the Bhilai and Bokaro steel plants have been delayed by 4 and 6 years, respectively. SAIL expected the Bhilai plant's expansion from 2.5 to 4.0 million tons of liquid steel and 3 million tons of salable steel to be completed by February 1988. The cost of this expansion rose from \$937 million to \$1.8 billion. Despite the expenditure, the Bhilai plant will

not be able to produce at rated capacity because of imbalances in different sectors of the plant. The Bokaro plant expansion to 4 million tons of liquid steel was scheduled for completion by September 1988 at a cost of \$1.7 billion compared with the original estimate of \$1.0 billion. SAIL plans, with assistance from the U.S.S.R., to further expand the Bokaro plant capacity to 4.5 million tons.

The cost of modernizing the Durgapur steel plant, revised twice since 1984, was estimated to be \$1 billion. The plan to increase capacity of liquid steel from 900,000 to 1,600,000 tons per year was approved by the Government.

The Japanese Iron and Steel Federation has recommended a \$2.3 billion modernization and expansion for Indian Iron and Steel Co.'s (IISCO) Burnpur plant in West Bengal. The plan would raise the capacity from 500,000 to 2,150,000 tons in two stages and make IISCO internationally competitive in both price and quality. The Japanese International Cooperation Agency was reportedly willing to fund a major portion of the program.

Japan's Nippon Steel Co. has proposed to take equity in the project. The proposal was politically controversial and received a mixed response from various high-level Indian Government officials.

SAIL planned a \$1.2 billion project to increase the Rourkela steel plant's capacity of liquid steel from 1.1 to 1.8 million tons per year. The Federal Republic of Germany may assist and fund part of the project. To date funding for the work has been meager, but SAIL scheduled completion for 1993.

The only new Government-owned integrated plant under construction in India was the Visakhapatnam steel plant (Vizag) in Andhra Pradesh. The plant has had serious delays and cost overruns—more than double the original projected cost. It was projected to begin iron production by December 1988 and steel production by 1991. The plant was expected to employ 14,000 workers when operating at its capacity of 3 million tons per year. Employment would be much lower than that at other SAIL plants, and this would help considerably in minimizing operating costs. Czechoslovakia was assisting in constructing the 850,000-ton-per-year medium merchant mill for producing small rounds, flats, and square shapes at Vizag. The Government was negotiating for the Czechoslovaks to finance the entire \$154 million cost of the mill scheduled for completion in 1993.

The private sector was taking a different view of steel industry progress. Its industry representatives thought that modern technology and modest-size plants could cut production costs. Examples of this were two plants under construction at Bhandhara, near Nagpur, and Hazira in Gujarat State. The Bhandhara plant is to produce 100,000 tons per year of steel with a capital cost of \$157 million. The capital cost per ton is one-half to one-third that of Government-owned integrated plants. It is a direct-reduction electric arc furnace facility using technology from the Federal Republic of Germany. It will employ only 750 workers and was scheduled to be completed in April 1988, only 25 months after construction began.

The Hazira plant, owned by the Essar Group of Gujarat, was to make sponge iron using Bombay High natural gas and iron ore pellets from the Kudremukh Mine in Karnataka. The plant would have a capacity of 880,000 tons and employ only 150 technical and 150 supporting workers. The company was to purchase an existing sponge iron facility in Europe. The cost of the plant through completion was estimated to be \$235 million.

Lead and Zinc.—At yearend, Government-owned Hindustan Zinc Ltd. (HZL) was awaiting Central Government approval to construct the long-planned \$475 million integrated lead-zinc mine and smelter complex in Chittorgarh District, Rajasthan. The smelter, in Chanderiya, was to have a capacity of 70,000 tons of zinc and 35,000 tons of lead per year. The mine and beneficiation plant were to be in the village of Agucha. According to the chairman of HZL, the complex could be commissioned in early 1991 if the Government granted approval by August 1988. By the seventh plan, \$20 million had been provided for the project, and \$124 million was to come from the United Kingdom through a grant-in-aid program. The remainder of the cost was arranged by the State Bank of India by issuing bonds. Furthermore, the project was expected to have a 28% internal rate of return and a payback period of only 4 years and 2 months. The debt-equity ratio was 35% and the foreign exchange savings during the project life of 20 years was estimated at \$2 billion.

The new proposed Chanderiya smelter would increase zinc and primary lead production capacity in India to 169,000 and 65,000 tons per year, respectively, in the 1990's. Demand was projected to rise to 206,000 tons of zinc and 107,000 tons of lead

by 1995 and to continue strongly upward. If the new project is implemented on time and all plants operate at capacity, there would still be a 70,000-ton deficit for each metal by the year 2000. On the other hand, if the Indian Government does not provide the funds, the metal deficit will increase while the project cost escalates. The cost to the nation in terms of metal imports and cost overruns could easily be more than the current cost of the project.⁷

HZL's production was affected by power and water problems at the Debari smelter in Rajasthan. HZL has not been able to achieve more than 84% of capacity at any time in recent years because of power problems. To solve the problems, HZL planned to install five diesel-powered generators of 5 megawatts each by April 1989.

Silver.—A one-third increase in silver production in FY 1987 was attributed to better performance at the Visakhapatnam zinc smelter and recovery of silver-copper concentrate at the Debari smelter in Rajasthan. The country's second silver-copper flotation plant was inaugurated in late 1987 at the Visakhapatnam smelter at a cost of \$2.4 million. It was expected that the Visakhapatnam silver-copper flotation plant would produce about \$1.7 million worth of silver concentrate per year.

Tin.—Sartin Ltd. of India plans to build a 300-ton-per-year tin smelter at Chowdwar in Madhya Pradesh. Sartin, a subsidiary of Saru Smelting Ltd. of Delhi, was set up to take advantage of State Government funding to encourage development of tin deposits. The smelter will use concentrates produced in Bastar District by Madhya Pradesh State Mining Corp. and Koraput District of Orissa. Some imported concentrates will also be used.

Base Metal Synergy Associated of the United Kingdom was to act as consultant to help with mining and processing. The Bastar District primary ore contains 0.25% tin and the primary ores near Mundaguda-frab in Koraput District range between 0.05% and 0.30% tin. The adjacent secondary alluvial deposits contain 0.9% to 2.0% tin. These primary and placer reserves were estimated to have a content of 2,000 and 2,800 tons of tin, respectively.

Titanium.—India's Defense Metallurgical Research Laboratory in Hyderabad has built an industrial-scale demonstration plant to produce titanium sponge from titanium tetrachloride. This reportedly makes India the sixth nation to produce titanium sponge. Mishra Dhatu Nigam Ltd. (Midha-

ni) in Hyderabad has been producing forged and machined titanium billets from imported titanium sponge.

The Nuclear Fuel Complex in Hyderabad has developed technology to produce consistently high-quality thin-walled, seamless titanium tubing. The plant uses a hot-extrusion process followed by cold tube-drawing to reduce the tube to the required size. This extremely expensive tubing, currently imported, is used for high temperature and corrosive applications such as power generation, chemical and oil refining, fertilizer production, and desalination.

INDUSTRIAL MINERALS

Barite.—Production continued to decline to about 212,000 tons in 1987, down from more than 580,000 tons in 1985. The decline resulted from a decrease in worldwide oil well drilling. Barite is used mainly to increase drilling-mud density in oil exploration. India also produced a small amount of snow white-grade barite for use in ceramics, paint, and paper. Indian Barytes & Chemicals Ltd. in Cuddapah District, Andhra Pradesh, has developed a red-grade barite having a specific gravity of 4.35 for high-density aggregate for undersea pipeline coating.

Cement.—The cement industry continued long-term expansion of its already large 52.7-million-ton capacity. It was estimated that 93 cement plants were operating at capacities of at least 600 tons per day each. Most of the growth has been in miniplants with capacities of 100 to 200 tons per day and from some smaller ones referred to as tiny cement plants with capacities of 20 to 100 tons per day. There were 54 miniplants in operation with a combined capacity of 2.9 million tons and about 90 miniplants in various stages of planning or construction with a capacity of 3.8 million tons per year.

Initial minimills had a maximum licensed capacity of 200 tons per day. However, in 1986 the Government increased the limit to 300 tons per day and in 1987 to 600 tons per day. Several companies were planning to take advantage of the new limit.

There were about 80 tiny cement plants in operation and an equal number in various stages of completion. Because of high transportation costs, both types use limestone from small local deposits in remote areas of the country so that they can compete with the distant rotary-kiln plants.

Construction of large rotary-kiln plants continued despite the competition from the small plants. Birla Jute & Industries, Ce-

ment Corp. of Gujarat, Dalmia Cement Ltd., Gujarat High Tech Industries, and Madras Cement Co. completed large new plants or expansions during 1987. In addition, at least six other large plants were under construction at yearend.⁹

Fertilizer Materials.—Two of the six urea fertilizer plants being built along the H-B-J natural gas pipeline were commissioned. The first to start operating was the National Fertilizer Ltd. Bijaipur plant in Madhya Pradesh. It has an ammonia capacity of 1,350 tons per day and two urea lines of 1,100 tons per day each. The second plant was owned by Indian Farmer's Fertilizer Cooperative and was at Aonla in Uttar Pradesh. Its capacity is similar to the Bijaipur plant and both use ammonia technology from Haldor Topsoe A/S of Denmark and urea technology from Snamprogetti S.p.A. of Italy. Other fertilizer plants with similar capacities along the pipeline were in various stages of planning or construction. The Jagdishpur plant was scheduled to be completed in mid-1988 and the Sawai Madhapur plant in mid-1989.

There was some question whether all of the plants would be constructed because of surplus nitrogen fertilizer in India and the high cost of production. Apparently, the question was resolved as Tata Chemical and Fertilizers Ltd. was proceeding with construction of its Babrala plant in Uttar Pradesh. Apeejay Fertilizers Ltd., not as far along, was still undecided about the choice of technology for the Shahjahanpur plant in Uttar Pradesh.⁹

Fluorite.—Gujarat Mineral Development Corp. (GMDC) announced it would expand its Kadipani flotation plant from a capacity of 20,000 to 50,000 tons per year. The plant, estimated to cost \$20 million, was to be completed in 1989. Feed to the State Government-owned facility was to be supplied by the Ambadungar surface mine in Baroda District, Gujarat. The plant produced two acid-grade and one metallurgical-grade fluorite concentrates. The metallurgical-grade material is marketed in either powder or briquetted form. GMDC accounted for 90% of India's fluorite production and met about 33% of domestic demand.

Concentration tests were conducted on ore samples from the Chandidongri deposit in Rajnandgaon District, Madhya Pradesh. During the 1960's the Bhilai steel plant mined high-grade ore from the deposit and produced a 90% CaF_2 -grade concentrate for its open-hearth furnace and an 82% CaF_2 -

grade concentrate for use in the foundry. With the high grade ore apparently depleted, tests were being conducted to determine whether a usable concentrate could be produced from the low-grade ore by froth flotation. A concentrate ranging from 60% to 83% CaF_2 was produced. The upper limit just met the foundry-grade quality but was not sufficient for modern metallurgical use.¹⁰

Gem Stones.—Gems and jewelry were India's single most valuable export and as such received considerable Government attention. The value of these exports to India, however, must take into account that virtually all supplies were imported and the value added was a modest 25% to 30%. The industry was almost wholly devoted to cutting and polishing loose diamonds of less than one-tenth carat. Government and private industry were examining ways to increase the value-added differential by cutting larger stones or manufacturing diamond studded jewelry. Cutting of colored stones was being considered as well.

Except for a period in the early 1980's, cut diamond exports have increased steadily from \$21 million in FY 1970 to \$1.5 billion in FY 1986.

India's main source of diamond was the De Beers Consolidated Mines Ltd. marketing wing, referred to as the Central Selling Organization (CSO). CSO sells diamonds in lots, called sites, to about 300 site holders 10 times per year. The site holders' only option is to buy or reject the entire site. Approximately 44 of the site holders were Indians, who bought 32% of India's diamond this way and then sold the diamond to other traders in smaller lots. CSO also sells to site holders in Antwerp. Most of India's remaining diamond came from dealers who buy from Antwerp site holders. The prices from Antwerp were higher but the purchasers had the option to select the diamonds they wanted.

India has explored non-DeBeers African sources with limited success. The MMTC was negotiating long-term trading agreements with African countries for direct imports of rough diamond. India has bought 2% of its stones from Ghana for several years. In December 1987, MMTC concluded an agreement to buy \$7 million worth of rough diamonds including high-priced diamond from Angola. Imports in recent years from all sources have been 40 million carats per year.

Indian diamond trading was centered in Bombay with most of the cutting done in

nearby Gujarat State. At yearend there were 40,000 shops employing 500,000 people in the diamond cutting industry. Most of these were small operations cutting in the traditional manner, but 25 shops were using modern technology.

India specialized in cutting and polishing tiny stones called makeables. There are two classifications of stones, makeables weighing 300 to 50 pieces per carat and sawns weighing 50 pieces per carat or larger. Sawns have regular grains (crystals) and can be worked on machines. India has purchased \$60 million worth of mechanized cutters, primarily, and laser equipment during the past several years.

India's main advantage, however, remained its ability to profitably cut irregularly grained makeables that cannot be cut profitably with high-tech traditional cutters. India also benefited from the increase in world supply of diamonds when Australian mines began production in 1983. Many of the diamonds from Australia were tiny stones that India cuts profitably.

The Indian Government has been looking for a way to increase taxes and value-added exports without disrupting the largely unregulated diamond cutters. One attempt was the creation of the Diamond Development Cooperative, the world's only industrial park designed expressly for diamond cutting. The park is 16 kilometers from Surat, Gujarat State, and was scheduled to open in March 1988 with 50 tenants. It was to employ 40,000 persons and have a diamond exchange, postal and customs facilities, offices for trading firms, a first class hotel, housing, a shopping center, and a hospital. The Hindustan Diamond Corp., the developer, is a joint venture of the Indian Government and a Bermuda banking affiliate of DeBeers.¹¹

The Indian jewelry industry has always been huge, but it was oriented strongly to traditional gold jewelry for the domestic and Mideast markets. The principal consumers in the Mideast were Indians and other South Asians working there. The demand was for heavy 22-carat items bought more for investment value than for fashion. Gold jewelry and trade are regulated strictly by the Government. Trying to meld the gem stone trade with finished jewelry exports was a complex and controversial problem. The amount and nature of Government involvement has yet to be determined.¹²

Mica.—India was the world leader in sheet mica production and one of its major

producers in lesser grades of mica. The industry consisted of privately owned companies, except for four small mines owned by the State Government of Bihar. Crude and processed mica exports were controlled by the Mica Trading Corp. (Mitco), a Government entity formed in 1974. During the past few years, Mitco has allowed a small but increasing amount of direct shipments by private mine owners. The annual export limit for a private owner was raised to 1 million rupees (\$77,000) in April 1987.

The number of operating mica mines has declined from more than 500 in 1970 to 150 in 1987. Bihar was the major producer, followed by Rajasthan and Andhra Pradesh.

Mitco has been building plants for manufacturing value-added mica products to earn more foreign exchange. Three plants were operating—a mica capacitor plant, a mica paper plant, and a micronized mica powder plant. Other projects under construction included two additional mica paper plants, each with a capacity of 300 tons per year; a 300-ton-per-year mica paper and splittings-based insulating material plant; and a 1,200-ton-per-year wet-ground mica powder plant. Mitco was also establishing a \$23 million mica research and development center to be financed by the MMTC. The center will focus on developing new mica products and additional mica applications.

Statistics on the Indian mica industry were illusive and contradictory. In addition to the 150 registered mines, there were many illegal operators who evaded taxes and did not comply with regulations. Reliable statistics were particularly hard to obtain in rural Bihar State where more than one-half of the mica is mined. Production and export figures traditionally have been significantly different. In 1986, for example, the Indian Government reported the production of 7,100 tons (revised) of all forms of mica with exports listed at 22,150 tons. Because domestic consumption was not included in the above figures and mica stocks were generally insignificant, production was estimated at 25,650 tons. The Government was concerned about revenue losses from such operations. It amended the Mines and Minerals (regulation and development) Act in 1986 to increase the penalties for those convicted of mining without a license. Despite this, illegal mining continued. In 1987, the Government appointed the Controller General of the Indian Bureau of Mines to assess the problems caused by illegal mining, transportation, and the sale

of various minerals, including mica.¹³

Mineral Sands.—The National Institute of Oceanography (NIO) announced the discovery of large deposits of ilmenite, conservatively estimated at 12.5 million tons, off the Konkan coast of Maharashtra. Three bays along the coast, Kalbadevi, Mirya, and Ratnagiri, have confirmed reserves of 2 million tons.¹⁴ The deposits are mostly under the seabed and may not be profitable to mine.

The privately owned Reliance Steel Ltd. (RSL) was seeking technical assistance and equity participation by Kerr McGee Chemical Corp. (KMCC) of the United States for a \$115 million titanium dioxide plant. The plant is to be in Chhatrapur, Orissa, where it would use synthetic rutile from the nearby public sector Indian Rare Earths Ltd. mineral sands separation plant. The plant would have an initial capacity of 36,000 tons per year and be completed in 1990. It would be a joint venture of RSL and State-owned Industrial Promotion and Investment Corp. of Orissa Ltd. (IPICOL). Of the \$31 million equity, RSL and KMCC would hold 20% each, IPICOL would hold 11%, and the remainder would be stock sold to the general public.¹⁵

The Berla Group, in collaboration with Bihar State Government, has proposed a 20,000-ton-per-year, \$46 million titanium dioxide plant. It would be based on the chloride process with chlorine feed supplied by the Bihar caustic soda and chemical plant, which was also a joint venture of Birla and Bihar State.

Talc.—India's Golcha Group (Associated Soapstone Distributing Co. (P) Ltd., Jaipur Mineral Development Syndicate (P) Ltd., Udaipur Mineral Development Syndicate (P) Ltd., and others) planned to increase production from 115,000 to 200,000 tons per year by 1990. Golcha produced about 90% of India's top-grade pure white talc from several mines in Rajasthan. India's talc industry employed 7,000 persons, mostly in Rajasthan.

MINERAL FUELS

Lignite.—The Federal Republic of Germany continued to provide financial and technical assistance to Neyveli Lignite Corp. Ltd. (NLC). The Federal Republic of Germany offered \$115 million toward continuing long-term development of the 3-billion-ton Neyveli deposits. The Neyveli II Mine will be expanded from 4.7 to 10.7 million tons per year by 1992 and the pitside powerplant will be expanded to a

1,470-megawatt capacity. Originally the plant was to have three 210-megawatt generators, the second of which was brought on-line during the year. The Neyveli I Mine also will be expanded from 6.5 to 10.5 million tons per year. Lignite from Neyveli Mine fuels the pitside 600-megawatt powerplant, which has been Tamil Nadu's primary electricity producer.

A third-phase development of the lignite deposits and powerplants reportedly have been approved by the central Government for the 1990-95 plan and may be financed by the Soviet Union. It will be a 15-million-ton-per-year mine and pitside powerplant of 1,500 megawatts and cost \$2 billion. NLC also has plans to expand out of State to develop a lignite mine and powerplant in Rajasthan.

A large lignite discovery has been made at Khandalia in the Bhavnagar District of Gujarat. Seams 4 to 13 meters thick were found at economically minable depths. Preliminary tests indicate that the quality was better than that of the Pandharo lignite mine in Kutch District.

Petroleum and Natural Gas.—India's petroleum outlook was satisfactory, particularly by developing country standards. The country, however, has been importing over one-third of its petroleum requirement and the proportion was expected to increase. Crude oil production has stagnated at about 225 million barrels annually, although demand is increasing more than 7% annually. Recent discoveries, primarily natural gas, have been small. India flared about one-third of the gas it produced.

If the trend continues, India may be producing less than 50% of the petroleum it consumes by the year 2000, contrasted with FY 1984 when it produced 80% of its needs. Although India's refineries were running at capacity, imports of refined products will inevitably rise, the amount depends on future refinery capacity. Refining capacity was 342 million barrels per year in 1987.

India's petroleum industry was owned and operated by the Government. All domestic crude oil and natural gas was produced by two Government-owned companies, Oil and Natural Gas Commission (ONGC) and OIL. This condition could change in the future because the Government signed exploration contracts with several foreign companies. In a change of policy, the Government gave wider authority to its Gas Authority of India Ltd. (GAIL) by allowing it to market all natural gas

produced by ONGC and OIL. GAIL was originally established in 1984 to construct and operate the H-B-J gas pipeline network from the offshore Bombay High area to North India.

Exploration.—The Indian oil companies have been conducting a vigorous exploration program that has been somewhat successful but without a major strike like Bombay High. ONGC's FY 1987 strategy onshore was to concentrate its efforts in Rajasthan and the Himalayan foothills. Offshore, it planned to employ new directional drilling technology that enables the drill to follow the horizontal oil-producing layer. ONGC hoped to exploit deep, previously untapped reserves at the South Bassin Field. It also planned to extend offshore drilling to ocean depths beyond 200 meters. ONGC planned seismic surveys of 119,000 line-kilometers onshore and 36,000 line-kilometers offshore. The company planned 274,000 and 142,000 meters of onshore and offshore drilling, respectively, during FY 1987. It deployed 110 rigs, 54 for onshore exploration, 14 for offshore exploration, and 42 for development drilling.

The program resulted in 15 oil and gas discoveries, including gas in the Agartala Dome in Tripura; oil and gas at Kumchal, Arunachal Pradesh; and oil at Thanjavore, Tamil Nadu, Diroi and Hapjan in Assam and at Kharsing in Arunachal Pradesh. Offshore strikes included several near Bombay High and one in the Krishna-Godavari Basin south of Visakhapatnam.

ONGC planned to continue seismic surveys in FY 1988 with 65,000 line kilometers onshore and 35,000 line kilometers offshore. Exploration drilling plans for FY 1988 were 695,000 meters onshore and 337,000 meters offshore.

OIL, much smaller than ONGC, continued exploring in Assam and Arunachal Pradesh, in the Mahandi Basin in Orissa, and offshore Andaman Islands. The company also began exploring in new areas. Six wells were planned for the Jaisalmer District of Rajasthan, close to the Pakistan border. Flooding and state border disputes in the Northeast hindered some of the exploration work. During the first 8 months of FY 1987, 21 wells were completed. Of these, 10 produced oil, 2 produced gas, and the remaining wells were still being tested. All three onshore holes in the State of Orissa were dry.

In 1986, the Government, desiring to accelerate oil exploration, invited Western oil companies to help explore for offshore oil

and gas. Earlier invitations in 1980 and 1982 received little response. Terms for the 1986 leasing tender were much more favorable for the oil companies; consequently, 7 companies submitted 12 bids for 9 of the 27 offshore blocks offered. Agreements were signed for all of the blocks. The leases were awarded as follows: Four to the U.S.-based Chevron-Texaco partnership, one to Switzerland-based International Petroleum Co. of Canada, one to Australia's Broken Hill Pty. Co. Ltd. (BHP), one to Shell International Inc., and one to Amoco of the United States. The Chevron-Texaco partnership and International Petroleum have completed their seismic programs.

Under a separate 1985 agreement, the U.S.S.R. was exploring onshore structures in Northern Cambay Basin, Gujarat, and onshore and offshore in the Cauvery Basin in Tamil Nadu on a turnkey basis. The Soviets were also preparing to explore two onshore sites and one offshore site near Calcutta in West Bengal where seismic surveys, conducted jointly with ONGC, indicated favorable geologic conditions. ONGC has drilled 15 wells in West Bengal without success.

Production.—Oil or gas has been found in several areas. Three strikes were made in the Krishna-Godavari Basin, which covers 20,000 square kilometers onshore and 37,000 square kilometers offshore in Andhra Pradesh, between the rivers for which it's named. ONGC has spent more than \$410 million in the area during the past 5 years. Three strikes have been made, the most favorable was offshore well GS-16 that was producing 5,000 barrels per day of oil and 5.6 million cubic feet per day of gas on an early production system. Additional development drilling was planned.

ONGC found the Gandhar Oilfield in Cambay Basin of Gujarat and the Panna Oilfield offshore, 90 kilometers northwest of Bombay. The Gandhar Field straddles the coastline 80 kilometers southwest of Baroda. Since 1984, 20 exploratory wells were drilled in the Gandhar Field. The field began production in June 1986 and was producing at more than 3,600 barrels per day at yearend 1987. Targeted production for FY 1989 was 4.6 million barrels of oil and 56 million cubic feet per day of natural gas. A pipeline spur from the Ankaleshwar-Baroda pipeline was planned.

ONGC proposed to install eight production platforms in the Panna Field. Annual production of 4.6 million barrels of oil by FY 1989 was envisioned.

Phase II production of offshore Heera Oilfield was to begin in an area 90 kilometers southwest of Uran and 70 kilometers from the South Bassein Gasfield. Seven production and support platforms were planned and 660-millimeter oil and 610-millimeter gas pipelines were to be built to the Uran oil refinery.

Pipelines.—At the end of FY 1987, India had 7,750 kilometers of pipeline transporting crude oil, natural gas, and refinery products from field to consumer. The Government planned a rapid expansion of this pipeline system. The Indian Oil Corp. was laying a 1,370-kilometer pipeline from Kandla, Gujarat, to Bhatinda, Punjab, which was scheduled for completion by 1992. It was part of the company's plan for a massive countrywide network of interconnecting pipelines. The 580-kilometer second phase of the H-B-J gas pipeline was completed to the city of Aonla in Uttar Pradesh. This section of the 1,740-kilometer line fed the Indian Farmer and Fertilizer Cooperative Ltd.'s Aonla nitrogen fertilizer plant. The first phase to Bijaipur, Madhya Pradesh, was completed in August 1987. The highest priority lines were the 300-kilometer Madras-Bangalore pipeline and a 500-kilometer Cochin-Trichy pipeline to be completed by 1990. Other lines planned were for servicing Assam, Delhi, Gujarat, and Uttar Pradesh.

ONGC proposed a national gas pipeline grid to make optimum use of India's natural gas supply, one-third of which was being flared. The plan envisioned a 11,500-kilometer distribution network to be built in three phases. Phase I was planned around proved reserves while Phases II and III were linked to potential reserves. Phase IA will extend the H-B-J pipeline 1,325 kilometers from Auriya, Uttar Pradesh, to Kapurthala, Punjab. Phase IB will be a 1,510-kilometer pipeline from Bangalore to Bombay. These segments will cost \$1 billion each.

Phase II will be a 5,600-kilometer network connecting the Phase I grid to Trivandrum, Kerala. Phase III envisions 3,250 kilometers of pipeline linking gas deposits in Northeast and East India to the national grid. The advantages of the proposed pipeline grids are obvious considering that 160 million barrels of crude oil and refinery products were moved in 1987 by rail—a slow, inefficient, and expensive method.

Refineries.—A shortage of refining capacity has developed gradually. India's capacity was 342 million barrels per year at the

end of FY 1987, with another 132 million barrels likely to be added by FY 1994. The increase will be provided by a 44-million-barrel-per-year plant in Baholi, 40 kilometers southwest of Karnal, Haryana; a 22-million-barrel-per-year refinery in Mangalore, Karnataka; a 14.7-million-barrel-per-year refinery in Assam; and the expansion of several refineries.

Construction of the Tata-Indian Oil Refineries Ltd. (TIORL) refinery in Karnal was scheduled to begin in late 1988. The cost was estimated to exceed \$1 billion. Tata Chemical and Fertilizers, the copromotor of the project, and Indian Oil Co. will each have 26% equity with the balance held by the public. The debt-equity ratio was to be 4:1. The Soviets have pledged to provide credit and equipment for the project.

In June, the Government's Hindustan Petroleum Corp. Ltd. (HPCL) and Birla's Indian Rayon and Industries Ltd. (IRIL) signed an agreement to construct a 22-million-barrel-per-year refinery at Mangalore, Karnataka. As with TIORL, HPCL and IRIL will hold 26% equity with the balance being held by the public.

Refineries slated for expansion include Koyali in Gujarat; Mathura in Uttar Pradesh; Bombay, owned by HPCL; and Kerala, owned by Cochin Refineries Ltd.

The Government announced that it will build five more 44-million-barrel-per-year capacity refineries during the next decade. If India expects to meet the projected long-term demand of 770 million barrels per year, it must increase capacity by an additional 293 million barrels per year. But, until then, India will need to import more refined products and crude oil.¹⁴

¹⁴Physical scientist, Division of International Minerals.

¹⁵Where necessary, values have been converted from Indian rupees (Rs) to U.S. dollars at the rate of Rs13.00=US\$1.00.

¹⁶The Indian fiscal year begins on Apr. 1 of the year stated.

¹⁷Mining Journal (London). V. 309, No. 7927, July 27, 1987, p. 62.

¹⁸Government of India, Indian Bureau of Mines. Indian Minerals Yearbook, 1986. Trade (Preprint). Pp. 819, 876.

¹⁹U.S. Consulate, Calcutta, India. Calcutta Airgram A-09, Oct. 5, 1987, p. 7.

²⁰U.S. Embassy, New Delhi, India. State Dep. Telegram 17956, R191155Z, July 1988.

²¹Rock Products. V. 91, No. 4, Apr. 1988, p. 63.

²²Nitrogen. No. 172. Mar.-Apr. 1988, p. 8.

²³Indian Mining and Engineering Journal. V. 26, No. 5, May 1987, p. 23.

²⁴Far Eastern Economic Review. V. 139, No. 7, Feb. 18, 1988, p. 64.

²⁵U.S. Embassy, New Delhi, India. State Dep. Telegram 18002, R200454Z, July 1988.

²⁶India's Mica Industry—Problems and Prospects. State Dep. Telegram 13625, R271326Z, May 1988.

²⁷Indian Mining and Engineering Journal. V. 26, No. 11, Nov. 1987, p. 25.

²⁸U.S. Embassy, New Delhi, India. State Dep. Telegram 30260, P162228Z, Dec. 1987, p. 2.

²⁹State Dep. Telegram 19075, R020721Z, Aug. 1988.